reichen Erhebungen des ADAC aus Nord- und Nordwestdeutschland vor, die von
KNIERER (1967) ausgewertet worden sind. Da sie jedoch keine Streckenkilometerangaben
enthalten, lassen sie sich nicht unmittelbar umrechnen. Doch 31 Totfunde im „bebauten
Gelände" gegenüber 45 auf Land- und Bundesstraßen weisen deutlich in die gleiche
Richtung. Wir halten daher die Befunde für grundsätzlich übertragbar.

Zusammenfassung

Fünfjährige Zählungen der überfahrenen Igel auf einer 150 km langen Teststrecke zwischen München
und Passau ergaben keine abnehmende Tendenz, aber ausgeprägte jahreszeitliche und biotopbedingte
Unterschiede in der Häufigkeit. Der Gesamtdurchschnitt beläuft sich auf 1 Igel/km/Jahr, aber die
freien Fluren, die 60,7 % der Strecke bilden, wiesen mit 0,6 Ex./km/Jahr einen vergleichsweise
geringen Wert auf. In kleinen Siedlungen (Durchfahrtstrecke unter 1 km) und am Rande größerer
gehen die Werte auf 5,0 bzw. 5,3 Igel/km/Jahr hoch, während die zentralen Abschnitte in größeren
Siedlungen mit 0,4 Ex./km/Jahr das Minimum bilden. Daraus ergibt sich, daß 86 % der 729
überfahren registrierten Igel auf nur 8,8 % der Strecke zu finden waren. Bei dieser Höhe der
Verlustquoten ist nicht auszuschließen, daß die verkehrsbedingte Mortalität lokal zum bestandssteu-
ernden Faktor wird. Im Jahresgang liegt der Gipfel der Verluste im Juni. Ein Nebenmaximum deutet
sich für den Oktober an.

Literatur

GÖRANSSON, G.; KARLSSON, J.; LINDGREN, A. (1976): Igelkotten och biltrafiken. Fauna och Flora 71,
    1–6.
HANSEN, L. (1969): Trafikdøden i den danske dyreverden. Dansk orn. for. tidsskrift 63, 81–92.
HEINRICH, D. (1978): Untersuchungen zur Verkehrsopferrate bei Säugetieren und Vögeln. Die
    Heimat (Neumünster) 85,; 193–208.
HODSON, N. L. (1966): A survey of road mortality in mammals. J. Zool. (London) 148, 576–579.
KNIERER, W. (1967): Untersuchungen über Tierverluste durch den Straßenverkehr. Z. Jagdwiss.
    13, 159–164.
KÖNIG, D. (1963): Der Igel, Erinaceus europaeus L., als Verkehrsopfer. Faun. Mitt. Norddeutschland
    2, 236–237.
RETTIG, K. (1965): Tierverluste auf Autostraßen. Orn. Mitt.17, 233–234.
SCHOENEMANN, W. (1977): Wildunfälle im Straßenverkehr. Zool. Beitr. N. F. 23, 169–219.
VAUK, G. (1964): Über die Höhe der Tierverluste auf unseren Straßen. Pirsch 16, 73–74.

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The activity of *Crocidura russula* (Insectivora, Soricidae) in the field and in captivity

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Abstract

Studied was the activity of the shrew *Crocidura russula* in the field (by radioactive tracking) and in
laboratory (by continuous recording of nest temperature and by video). Under natural conditions, the
total daily activity remained nearly constant throughout the year accounting for about 33 % of the
total time. Activity was polyphasic and showed a daily rhythm; on an average, one activity phase
occured every two hours and lasted 36 min. The activity periods of captive shrews were generally
shorter, but always more frequent, and the total daily activity of captive shrews was much lower in

winter. Two experiments carried out in the field on shrews artificially fed, demonstrated that under natural conditions, foraging takes a major part of the winter activity. The activity patterns of *Crocidura russula* are compared with those of another European shrew, *Sorex araneus*.

Introduction

The activity of the Soricidae in the field is still little known. Most of the existing data are the result of indirect observations, coming either from trapping experiments during which the traps were visited at regular intervals (SPENCER-BOOTH 1963; SHILLITO 1963; ROOD 1965; PERNETTA 1973, 1977; BÄUMLER 1975; NEWMAN 1976), or from recordings made in places frequented by the shrews (INGLES 1960; DOUCET and BIDER 1974). Most of these data give some information on the rhythm of activity, and some show an influence of climatic factors on the activity. However, only the observations of KARULIN et al. (1974) on *Sorex araneus*, based on radioactive tracking, provide time budgets of free-living shrews.

Laboratory studies are much more numerous. The genera *Sorex* and *Blarina* among the Soricinae, as well as *Crocidura* and *Suncus* among the Crocidurinae have been extensively studied (lit. in VOGEL et al. 1981). Unfortunately, the observations often relate to limited periods and have sometimes been made under poorly described circumstances; experimental conditions undoubtedly have a determining influence on the activity. Furthermore, the results of KARULIN et al. (1974) suggest differences in the activity of captive and free-living shrews, hence information obtained on captive animals should be interpreted cautiously.

Crocidura russula (Hermann, 1780) is widespread in Europe. Its metabolic rate is similar to that of the other Crocidurinae which, for the most part, inhabit the paleotropical region. On the other hand, metabolism in this species differs distinctly from that of the sympatric Soricinae (VOGEL 1976). The physiological and behavioural mechanisms which influence the energy budget of this species in the temperate zone, especially during the winter period, are therefore of particular interest. The activity patterns and the total daily activity are important behavioural adaptations by which a species copes with its environment. Up to the present time, these adaptations have been only little described in *Crocidura russula* (SAINT GIRONS 1959, 1966; GODFREY 1978; VOGEL et al. 1981).

Material and methods

Observations under natural conditions

Observations in the field have been carried out within two populations followed regularly by live-trapping, at Bassins (750 m) and Préverenges (375 m) in Switzerland. The first locality has been previously described (GENOUD and HAUSSER 1979). Préverenges consists of houses separated by parks and gardens, and the population studied lives in thuya and hornbeam hedges bordering lawns.

Shrews were weighed, sexed, marked by means of an auricular ring bearing a filament of radioactive tantalum ([182]Ta), and followed continually during over 24 h (GENOUD and HAUSSER 1979). As a rule, the observations made during the two hours following marking (effected under light anaesthesia) were not retained: in certain experiments, this period seemed to show an intensification of the activity, probably due to the stress that inevitably accompanies marking. With this restriction, it can be accepted that the impact of the method on the behavioural parameters observed is negligible. BARBOUR and HARVEY (1968) noticed no significant differences in the activity of unmarked and radioactive tag-carrying rodents. The duration of each of our experiments was reduced to a minimum to limit the dose received by the shrews. The ring seemed to be sufficiently light (0.1 g) not to hamper them in any way. A control-experiment was implemented to detect any possible effect of the observer on the activity of the individuals followed. Following a typical experiment (no 4), 10 Geiger-Müller probes were set out throughout the home range of the marked shrew. In this way, its activity was automatically recorded for 5 additional days by means of a device described by AIROLDI (1979). No influence of the observer was detectable (table 1, experiments no 4 and 4c).

As a rule, absence from nest was considered to be an indicator of activity; however, complete

immobility of more than 10 min outside a nest was interpreted as a rest. The microclimatic conditions in the places frequented by the shrews were recorded during the course of each experiment. The temperature of the soil (– 10 cm) near the nests, and the ambient temperature in the litter (+ 2 cm) were recorded. The mean ambient (litter) temperature was used to characterise the general thermal conditions during each experiment.

Complementary experiments in the field

In certain habitats, *Crocidura russula* regularly takes advantage of man-made sites which offer favourable energetic conditions (GENOUD and HAUSSER 1979); it therefore seemed worthwhile to study the activity of individuals under conditions made extremely favourable artificially. Two shrews, given ad libitum access to minced meat at a feeding station on their home ranges, were marked (on 6. 9. 1978 and from 27. to 31. 1. 1980). Feeding started a week before marking for the summer experiment. The individual marked in winter was fed from October; its feeding point was not supplied on the last day of the experiment (31. 1. 1980).

Observations in captivity

Four individuals (2 males and 2 females) born in captivity in June 1976, were followed intensively for one year: monthly recordings of their activity constitute the basis of our captivity study. Twenty-two supplementary recordings were made at various times of the year on 22 individuals captured in the field and acclimatised to captivity for at least one month.

Captive shrews were maintained individually in cages measuring 30 × 50 cm, and kept in a room exposed to the natural climatic fluctuations (temperature, humidity, light). Each cage had an earth and peat floor and a wooden nest (5.5 × 5.5 × 4.5 cm) filled with dry hay. Water and food (a mixture mostly consisting of minced meat) were always available ad libitum.

All the observations were made under climatic conditions similar to those of the field. The recordings of the activity of the 4 individuals followed for one year were performed while the animals occupied their normal cage and room; the other individuals (supplementary recordings) were transferred to a new cage (similar to that in which they were normally kept) at least 2 days before the recordings.

The activity (= absence from nest) of the shrews was studied by means of the continuous recording of nest temperature (VOGEL 1974). Each recording lasted on an average 4 to 5 days and was accompanied yy a check of the physical condition of the studied shrew and by measurements of the climatic conditions. Moreover, 17 of the supplementary recordings, evenly distributed over the annual cycle, were accompanied by a study of the behaviour during activity. During these recordings, 2 samples of 30 min activity (one during the night and one during the day) were filmed by means of a video installation equiped with an infra-red camera. During the night, a dim red lamp gave suitable illumination. The activity was divided into "displacements" and "stations" (no displacement for more than 10 sec); different stations for different functions were distinguished: water and food intake, self-grooming, stationary exploration (digging, olfactory exploration, etc.), rest, short visits to the nest. This last behaviour, frequent when the activity rate was high, led us to define arbitrarily rest as a presence in the nest of more than 2 min.

Results

Activity under natural conditions

The 13 experiments carried out under natural conditions took into account most of the situations met with by the species in both localities (season, temperature, physiological condition). They were divided into 5 relatively homogeneous seasonal groups (table).

The total daily activity (t.d.a., table) remained fairly constant throughout the year. It was independent of the mean ambient temperature in the litter (figure 1): the correlation and regression coefficients (0.16 and 2.0 min/°C) were not statistically significant ($P > 0.05$). On an average, the shrews were active for 478 min each day (33 % of the time). Only group 4, with slightly lower values, differed appreciably from the others; however, the data are insufficient for this divergence to be interpreted. The standard deviations of t.d.a. in the 13 experiments (92 min) and in the experiments 4 and 4c (6 d of continuous observation of the same shrew) (76 min) differ only little; hence, most of the variability of t.d.a. may be due to fluctuations which occur from day to day in the activity of each individual.

Table

Principal characteristics of the experiments carried out under natural conditions

Seasonal group	Experiment	Date	Mean ambient temperature in the litter (°C)	Sex	Weight (g)	t.d.a. (min)	d.r.a. (min/h)	n.r.a. (min/h)
1. summer, young	1	15. 08. 79	21.3	♀	10.1	592	8.6	48.6
	2	20. 09. 79	18.0	♂	11.8	399	20.2	12.6
2. autumn, individuals of the year	3[1]	12. 10. 77	11.5	♂	12.0	626	29.9	22.8
	4	25. 10. 79	12.3	♀	9.0	481	19.4	20.6
	4[2]	26.–30.10.79	8.6			431 ± 82	18.9 ± 6.7	17.3 ± 3.7
	5[1]	09. 11. 77	12.1	♀	11.8	419	7.2	24.3
3. wintering individuals	6[1]	30. 11. 77	−4.0	♂	11.0	459	0.2	32.6
	7[1]	21. 12. 77	5.2	♂	11.5	536	18.4	24.5
4. spring, adults	8	27. 03. 79	9.4	♀	12.7	298	1.9	24.0
	9	26. 04. 79	8.6	♀, lac	11.4	430	8.5	31.5
5. summer, adults	10	30. 05. 79	17.9	♂	12.0	595	19.2	35.3
	11	18. 07. 78	20.0	♂	15.5	418	10.8	29.5
	12	18. 07. 79	20.6	♀	14.4	468	18.5	21.3
	13	06. 09. 79	16.1	♂	11.8	499	12.5	30.8

t.d.a. = total daily activity; d.r.a. = mean diurnal hourly rate of activity; n.r.a. = mean nocturnal hourly rate of activity; lac. = lactating female
[1] Experiments carried out at Bassins. – [2] Control experiment (5 d, means and standard deviations)
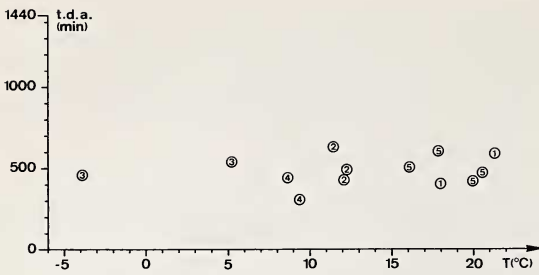
Fig. 1. Total daily activity (t. d. a.) in *Crocidura russula* in the field, in relation to the mean ambient temperature in the litter (T). The seasonal group (according to the table) is indicated for each experiment

The daily activity showed a polyphasic pattern (figure 2). 12.7 $\pm$ 2.3 ($\bar{x} \pm$ SD) periods of activity occured each day (9 to 17), on an average slightly more than one every 2 h. They lasted on an average 36 min (1 to 222 min) and were generally longer at night than at day (on average 45 min against 29 min). Very short activity periods (less than 5 min) were often observed at day; during these, the shrews probably left their nest only for urination and defecation. The periods of rest had a very variable length (4 to 602 min), the mean being 74 min; they were generally shorter at night than at day (on average 55 against 95 min).

The intensity and position of the activity peaks over 24 h varied from one experiment to another; some fluctuations also occured from day to day in the same shrew (control-experiment, table). Meteorological conditions are likely to be partly responsible for these variations, as was shown in experiment no 1, where almost continuous nocturnal activity (table and figure 2) was probably due to a shower which occured at dusk (following 3 weeks without rain). However, in most cases the activity showed a daily rhythm characterised by a nocturnal maximum and a diurnal minimum, usually in the morning. This rhythm is reflected in the day-time and the night-time hourly rates of activity (table, d.r.a. and n.r.a.), of which the respective means (13.5 $\pm$ 8.4 min/h and 27.6 $\pm$ 8.8 min/h) are significantly different (P < 0.01). Only 2 experiments showed a higher activity rate at day than at night. The diurnal and nocturnal activity rates are independent of the mean ambient temperature in the litter: the correlation and regression coefficients are not significant (P > 0.05). Nevertheless, the mean activity profiles established for the different seasonal groups allow us to point out some seasonal trends in the temporal organisation of the activity (figure 3). In winter and in spring, a single nocturnal peak was generally observed. In summer, an ad-
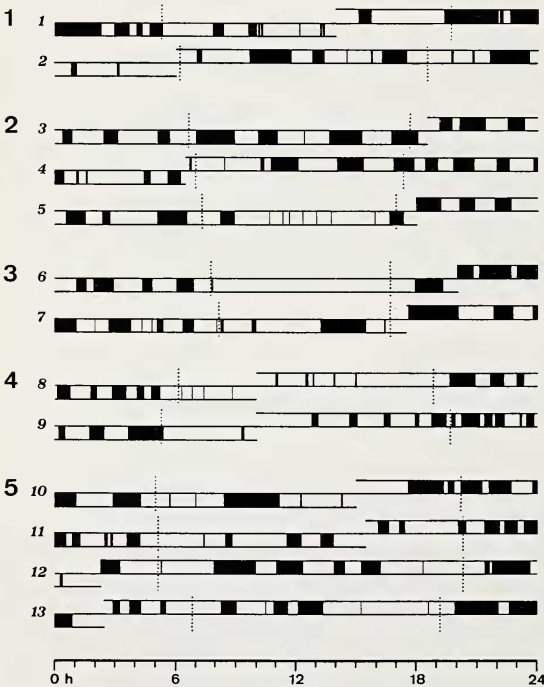

Fig. 2. Activity patterns obtained for *Crocidura russula* in the field (activity periods in black). Bold numbers: seasonal groups (according to the table); no of the experiment in italics; dotted lines: sunset and sunrise

ditional peak, probably linked to the lengthening of the day, often occured in midday. In autumn, important variations were observed; in particular, experiment no 3 stood out by the absence of a marked daily rhythm (figure 2).
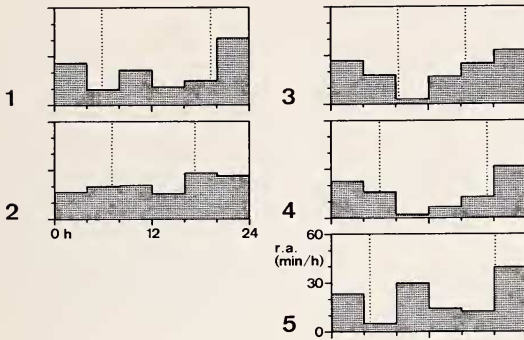

Fig. 3. Mean activity profiles (r. a. = hourly rate of activity, means per 4 hours interval) of *Crocidura russula* in the field. For each seasonal group (according to the table) the mean of the experiments concerned has been represented. Dotted lines: mean sunset and sunrise

Activity in captivity

Results of all the captive shrews are comparable to one another, and those of the 4 individuals followed over one year (196 days of recording) appear representative of the whole. Hence, exepting data on the behaviour during activity, only the results from these 4 shrews are cited.

During almost the entire annual cycle, the physical condition of the captive shrews differed strongly from that of the freeliving individuals. Their moults often lasted several months and their weight was generally distinctly higher than those measured in the field. Weighing 11.1 ± 1.7 g during their first summer, the 4 individuals followed greatly increased from the autumn to reach a winter weight of 14.4 ± 2.0 g. Their weight again increased in the spring to reach 16.7 ± 3.0 g in the second summer.

The total daily activity varied considerably from one season to another. It was generally similar to that observed in the field among the young in summer, but diminished from the autumn and remained at a significantly lower level ($P < 0.01$) during the whole of the winter. High values were again reached in the adults during spring; however, no sudden intensification of activity was noticed at the onset of the reproductive period (indicated by the strong odour of the males). Certain old adults in summer had again low activity levels. Within the limits of the experimental conditions, the total daily activity of the 4 individuals followed for one year is linked to the mean ambient temperature (figure 4; correlation coefficient = 0.81, significant [$P < 0.01$]; regression coefficient = 16.9 min/°C).

As in the field, the activity was polyphasic in captivity and showed a daily rhythm characterised by a nocturnal maximum and a diurnal minimum, generally in the morning. This rhythm was very conspicuous among the young in summer. It was much less marked in winter, when it was sometimes only just discernable (see figure 3 in VOGEL et al. [1981], partially based on the present results). The hourly rate of diurnal activity was always very low (4.1 ± 2.1 min/h) and varied little during the course of the year; it was slightly dependent on the ambient temperature (correlation coefficient = 0.27, significant [$P < 0.01$]; regression coefficient = 0.1 min/h°C). On the other hand, the night-time hourly rate was very variable from one season to another, but always significantly higher than the diurnal rate ($P < 0.01$). Among the 4 individuals followed, it fell from 39.5 ± 8.6 min/h in August (20 d of recording) to 9.6 ± 2.2 min/h in January (18 d of recording). Within the limits of the experimental conditions, it is strongly linked to the ambient temperature (correlation coefficient = 0.84, significant [$P < 0.01$]; regression coefficient
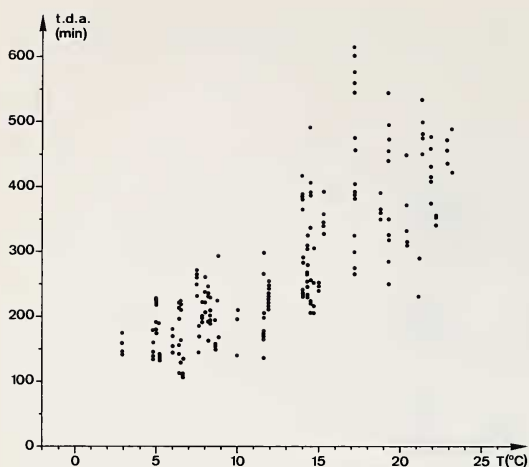
Fig. 4. Total daily activity (t. d. a.) in relation to ambient temperature (T) in 4 *Crocidura russula* followed for one year in captivity. For each recording, every day has been reported against the mean ambient temperature during the recording

= 2.0 min/h°C): the variations of the total daily activity are thus principally linked to variations in the nocturnal activity.

In captivity, the periods of activity and rest were very variable in duration, but were generally shorter and always significantly more frequent (P < 0.01) than in the field. Their mean frequency and duration differed between night and day, and varied during the course of the annual cycle. The 4 individuals followed left their nest 22.9 ± 7.8 times each day in August; this frequency increased to 42.4 ± 6.0 activity periods per day in January. The duration of the diurnal periods of activity remained constant throughout the year (on average 3 min). On the contrary, the nocturnal periods were generally long (47 min on average in the young in August) when the rate of nocturnal activity was high and their duration lowered to the diurnal values in winter (on average 5 min in January). The duration of the nocturnal periods of rest varied little during the year (on average 23 min); the diurnal periods were longer in the young during summer (on average 69 min in August) than in wintering shrews (on average 47 min in January). However, it should be remembered that an inferior limit of length of the rest periods was arbitrarily fixed; by high activity rates, this biases (although not to a too large extent) the estimations of the frequency and duration of the periods of activity and rest.

The behaviour of the captive shrews can be described by the proportion of time (calculated after the filmed samples) that they spend in each of the behaviours defined. Displacement, stationary exploration, food intake and self-grooming always took up more than 95 % of the time spent outside the nest; the relative proportion of these 4 behaviours is linked to the hourly rate of activity (figure 5). By high activity rate (nocturnal activity in summer), displacement and stationary exploration largely dominated. On the other hand, by low activity rate, displacement, food intake and self-grooming divided up the time in similar proportions; at that time, exploratory activity was almost nonexistent.

Influence of artificial feeding in the field

The activity exhibited during the summer complementary experiment was not strongly different from that which was usually observed under natural conditions (t.d.a. = 405 min; 19 activity periods per day, with a mean length of 23 min). On the contrary, artificial feeding had a spectacular impact in winter. The marked shrew showed a relatively high weight (13 g) and in a number of respects its activity was similar to that exhibited by captive wintering shrews. Between 28. and 30. 1. 1980, at a mean ambient temperature in

Fig. 5. Nocturnal hourly rates of 4 behaviours (n. r. d. = displacement; n. r. e = stationary exploration; n. r. f. = food intake; n. r. g. = self-grooming) in relation to the mean nocturnal hourly rate of activity (n. r. a.) in captive *Crocidura russula*. Each point is based on the analysis of 30 min activity
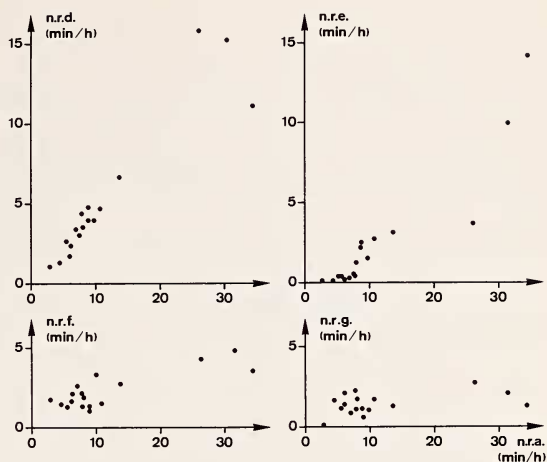
the litter of 2 °C, its total daily activity amounted 208 ± 41 min. The activity periods were a little more frequent (18.7 ± 2.1 periods per day) and, above all, much shorter (11 min on average) than under natural conditions; they were often limited to a short visit to the feeding point. The suppression of the artificial feeding on the last day of the experiment led to an immediate reaction of the shrew, characterised among other things by an increase in the total daily activity (495 min).

Discussion

In captivity, in an extremely simplified environment, the activity of *Crocidura russula* is strongly different from that observed under natural conditions. Few of its qualitative aspects, such as the polyphasic pattern and the presence of a daily rhythm, are retained. The increased frequency of the activity periods, and the reduction, at low temperatures, of the total daily activity, itself linked to a reduction in locomotory and exploratory activity, characterise the activity of the captive shrews. These pecularities, together with the abundant food supply, inevitably lead to an increase in body weight. The results of VOGEL et al. (1979) also show that in captivity, "natural" weights can only be maintained by subjecting the shrews to a restricted diet. The conclusions based on observations made in captivity, even under climatic conditions approaching those in the field, can in no case be extended to free-living animals.

Our observations on the activity of *Crocidura russula* in captivity, are hardly comparable to those of other authors (SAINT GIRONS 1959, 1966; GODFREY 1978), mainly because the experimental conditions are different (acclimatisation, season and temperature). However, it should be noted that GODFREY (1978) obtained similar results for the frequency and duration of the activity periods with freshly captured shrews; it seems probable, therefore, that 2 to 3 days after capture, the behaviour of a captive shrew has already become very different from that of a free one.

The day to day variations in the activity of *Crocidura russula* in the field are first of all due to the individuals themselves; considerable fluctuations are observed even in captivity where the conditions are more stable. Short-term meteorological changes are also partly responsible for the variability observed. The influence of rain on the activity of other species of Soricidae is particularly known (DOUCET and BIDER 1974; BÄUMLER 1975).

The absence of marked seasonal variations in the total daily activity of *Crocidura russula* in the field must be stressed. This phenomenon is again found in *Sorex araneus*, where the

observations of KARULIN et al. (1974), made under varied environmental conditions, also suggest only little seasonal variations. It should be noted, however, that we marked no male at the onset of the reproductive period; at this time, they seem particularly mobile (GENOUD 1978; GENOUD and HAUSSER 1979). While the total daily activity of the shrews remains constant throughout the year, the motivations for this activity change strongly from one season to another. In winter, a high activity level is maintained in the field, whilst it is low in captive individuals. However, it is sufficient to artificially feed a shrew in the field to bring its total daily activity near the captivity values. Thus it clearly appears that foraging takes up an essential part of the winter activity of *Crocidura russula*, a fact already pointed out by CROWCROFT (1954) and BUCHALCZYK (1972) for representatives of the genus *Sorex*. It follows that the diminution of activity which occurs among the captive shrews in winter is principally due to the presence of food available ad libitum. The summer activity of *Crocidura russula* in the field, on the other hand, is only secondarily motivated by foraging: it cannot be markedly influenced by artificial feeding. In summer, exploration and reproduction may take up a large part of the activity.

In captive shrews, the frequency of the periods of activity may depend essentially on physiological (particularly nutritional) requirements (CROWCROFT 1954; SAINT GIRONS 1959). Our own observations show that for comparable climatic conditions, the activity periods are much less frequent in the field. Most of the other patterns related to the rhythm of activity (duration of the periods of activity and rest, intensity and position of the activity peaks during the 24 h) also show differences between free-living and captive shrews. Under natural conditions, many factors (not only physiological, but also ecological and behavioural) concur to structure the activity pattern best adapted to the environment. Depending on the local conditions, individuals of different populations may therefore have different activity patterns. According to PERNETTA (1973), *Crocidura suaveolens* may even adapt its rhythm to that of the tides in coastal areas.

The Crocidurinae and the Soricinae have developed very different biological strategies (VOGEL 1980, for an actual synthesis). In particular, the Soricinae are characterised by higher resting metabolic rates (VOGEL 1976). Several authors have tried to show, but always on the basis of data obtained in captivity, how these different strategies are manifested in the rhythm and daily duration of activity (GERAETS 1972; BAXTER et al. 1979; VOGEL et al. 1981). The results of KARULIN et al. (1974), together with our results, allow us to make a first comparison between the activity patterns of *Crocidura russula* (Crocidurinae) and *Sorex araneus* (Soricinae) in the field, 2 species of similar size which are sympatric over a large part of Europe. Under all the conditions tested, *Crocidura russula* is distinctly less active than *Sorex araneus;* its periods of activity are shorter and its resting periods longer. It should be noted in particular, that these rest periods never reach 100 min in *Sorex araneus*, whereas periods of rest of more than 100 min are frequent in *Crocidura russula*. These differences, which obviously cannot be generalised to all representatives of the 2 subfamilies, are consistent with the known physiological and behavioural characteristics of the 2 species.

Zusammenfassung

Die Aktivität von Crocidura russula (Insectivora, Soricidae) im Freiland und in Gefangenschaft

Aktivitätsdauer und -rhythmus der Hausspitzmaus *(Crocidura russula)* wurden in Wildpopulationen mittels radioaktiv markierter Tiere und in Gefangenschaft bei vergleichbaren klimatischen Bedingun-

gen mittels kontinuierlicher Aufzeichnung der Nesttemperatur sowie zusätzlicher Videoaufnahmen untersucht.

Im Freien ist die Aktivität polyphasisch und weist einen Tagesrhythmus mit einem nächtlichen Maximum und einem morgendlichen Minimum auf. Im Durchschnitt wird ungefähr alle 2 h eine Aktivitätsphase von 36 min beobachtet. Die Tagesaktivität ist das ganze Jahr über relativ konstant und beträgt im Durchschnitt 33 % der Zeit.

Die Ergebnisse in Gefangenschaft weichen von den Freilandbeobachtungen stark ab. Die Aktivitätsphasen sind kürzer und häufiger als im Freien. Das Tagestotal der Aktivität zeigt einen charakteristischen Jahresverlauf, im Winter wird die lokomotorische und exploratorische Aktivität stark reduziert.

Zwei Freilandexperimente, in deren Verlauf Wildtieren Futter ad libitum angeboten wurde, zeigten, daß Futtersuche den größten Teil der Winteraktivität ausmacht; in Gefangenschaft erlaubt das uneingeschränkte Futterangebot, die Aktivität im Winter stark einzuschränken.

Das Aktivitätsmuster von *Crocidura russula* (Crocidurinae) zeigt gegenüber jenem von *Sorex araneus* (Soricinae) klare Unterschiede, die durchaus zu den bekannten physiologischen und ethologischen Eigenheiten der beiden Arten passen.

References

AIROLDI, J.-P. (1979): Etude du rythme d'activité du campagnol terrestre, *Arvicola terrestris* Scherman Shaw. Mammalia **43**, 25–52.

BARBOUR, R. W.; HARVEY, M. J. (1968): The effect of radioactive tags on the activity of rodents. Am. Midl. Nat. **79**, 519–522.

BÄUMLER, W. (1975): Activity of some small mammals in the field. Acta theriol. **20**, 365–377.

BAXTER, R. M.; GOULDEN, E. A.; MEESTER, J. (1979): The activity patterns of some southern African *Crocidura* in captivity. Acta theriol. **24**, 61–68.

BUCHALCZYK, A. (1972): Seasonal variations in the activity of shrews. Acta theriol. **17**, 221–243.

CROWCROFT, P. (1954): The daily cycle of activity in British shrews. Proc. zool. Soc. Lond. **123**, 715–729.

DOUCET, G. J.; BIDER, J. R. (1974): The effects of weather on the activity of the masked shrew. J. Mammalogy **55**, 348–363.

GENOUD, M. (1978): Etude d'une population urbaine de musaraignes musettes, *Crocidura russula* (Hermann, 1780). Bull. Soc. Vaud. Sc. Nat. **74**, 25–34.

GENOUD, M.; HAUSSER, J. (1979): Ecologie d'une population de *Crocidura russula* en milieu rural montagnard (Insectivora, Soricidae). Terre Vie, Rev. Ecol. **33**, 539–554.

GERAETS, A. (1972): Aktivitätsmuster und Nahrungsbedarf bei *Suncus etruscus*. Bonn. zool. Beitr. **23**, 181–196.

GODFREY, G. K. (1978): The activity pattern in white-toothed shrews studied with radar. Acta theriol. **23**, 381–390.

INGLES, L. G. (1960): A quantitative study on the activity of the dusky shrew *(Sorex vagrans obscurus)*. Ecology 41, 656–660.

KARULIN, B. E.; KHLYAP, L. A.; NIKITINA, N. A.; KOVALEVSKII, Yu. V.; TESLENKO, E. B.; AL'BOV, S. A. (1974): Activity and use of refuges of the common shrew (from observations of animals labelled with radioactive cobalt). Byull. Mosi. O-Va. Ispyt. Prir. Otd. Biol. **79**, 65–72.

NEWMAN, J. R. (1976): Population dynamics of the wandering shrew *Sorex vagrans*. Wasmann J. Biol. **34**, 235–250.

PERNETTA, J. C. (1973): The ecology of *Crocidura suaveolens cassiteridum* (Hinton) in a coastal habitat. Mammalia **37**, 241–256.

— (1977): Population ecology of British shrews in grassland. Acta theriol. **22**, 279–296.

ROOD, J. P. (1965): Observations on the home range and activity of the Scilly shrew. Mammalia **29**, 507–516.

SAINT GIRONS, M. C. (1959): Les caractéristiques du rythme nyctéméral d'activité chez quelques petits mammifères. Mammalia **23**, 245–276.

— (1966): Le rythme circadien de l'activité chez les mammifères holarctiques. Mém. Mus. Natn. Hist. nat., Paris, Sér. A 40, 101–187.

SHILLITO, J. F. (1963): Field observations on the growth, reproduction and activity of a woodland population of the common shrew *Sorex araneus* L. Proc. zool. Soc. Lond. **140**, 99–114.

SPENCER-BOOTH, Y. (1963): A coastal population of shrews *(Crocidura suaveolens cassiteridum)*. Proc. zool. Soc. Lond. **140**, 322–326.

VOGEL, P. (1974): Kälteresistenz und reversible Hypothermie der Etruskerspitzmaus (*Suncus etruscus*, Soricidae, Insectivora). Z. Säugetierkunde **39**, 78–88.

— (1976): Energy consumption of European and African shrews. Acta theriol. **21**, 195–206.

— (1980): Metabolic levels and biological strategies in shrews. In: Comparative physiology of primitive mammals. Ed. by SCHMIDT-NIELSEN. London: K. Cambridge Univ. Press. pp. 170–180.

Vogel, P.; Burgener, M.; Lardet, J.-P.; Genoud, M.; Frey, H. (1979): Influence de la température et de la nourriture disponible sur la torpeur chez la musaraigne musette *(Crocidura russula)* en captivité. Bull. Soc. Vaud. Sc. Nat. 74, 325–332.

Vogel, P.; Genoud, M.; Frey, H. (1981): Rythme journalier de l'activité chez quelques Crocidurinae africains et européens (Soricidae, Insectivora). Terre Vie, Rev. Ecol. 35, 97–108.

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Bemerkungen zur taxonomischen und stammesgeschichtlichen Position der Gibbons (Hylobatidae, Primates)

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Abstract

Remarks upon the taxonomic and phylogenetic position of gibbon and siamang (Hylobatidae, Primates)

Discussed is the taxonomic and phylogenetic position of the gibbon and siamang (Hylobatidae). A brief historical survey demonstrates the different viewpoints on the systematic position (Hylobatidae or Pongidae [Hylobatinae] or Hominidae [Hyloblatinae]) among the Hominoidea or Hyloblatidae within the Cercopithecoidea. Morphological, anatomical, karyological and biochemical facts demonstrate that gibbon and siamang are neither members of the Hominoidea nor Cercopithecoidea. The hylobatids are members of an own category (superfamily Hylobatoidea [Thenius 1969]). The taxonomical position of the Hylobatoidea is between the Cercopithecoidea and Hominoidea, but they are neither intermediate nor phyletic transitional forms, as suggested by Kohlbruegge (1890/92). Hylobatids have separated early from the other catarrhines. The ancestors are pliopithecids *(Propliothecus)* of the Oligocene in Africa. *Dendropithecus* (Miocene, East Africa) is a primitive member of the hylobatids. The resemblances with pongids are the result of either a parallel evolution or of symplesiomorph features.

Einleitung und Problemstellung

Anlaß zu den folgenden Zeilen war das umfassende Werk von Szalay und Delson "Evolutionary history of the primates" (1979). Szalay und Delson, die sich seit Jahren mit fossilen Primaten befassen, klassifizieren die Gibbons als Unterfamilie (Hylobatinae) der Hominidae, wie es Delson bereits früher (in Luckett und Szalay 1975) zum Ausdruck gebracht hat. Diese Zuordnung basiert auf der Annahme, daß die im Zusammenhang mit der Fortbewegung erworbenen Merkmale im Handgelenk bei den Hominoidea (im Sinne von Simpson 1945) synapomorphe Merkmale sind (vgl. Lewis 1965; Andrews und Groves 1976).

Die taxonomische Zuordnung bzw. Bewertung der Gibbons erfolgt keineswegs einheitlich, wie eine Durchsicht der Literatur erkennen läßt.

Im folgenden wird der Versuch gemacht, die systematische und phylogenetische Position der Gibbons nicht nur auf Grund morphologisch-anatomischer Merkmale zu beurteilen, sondern auch nach karyologischen (cytogenetischen) und biochemischen (immunologischen) Befunden.